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Oka et al.

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(54) **SEMICONDUCTOR DEVICE AND METHOD OF MANUFACTURING THE SAME**

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(73) Assignee: **Seiko Epson Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **07/790,107**

(22) Filed: **Nov. 7, 1991**

Related U.S. Application Data

(63) Continuation of application No. 07/479,396, filed on Feb. 13, 1990, now abandoned.

(30) **Foreign Application Priority Data**

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Oct. 4, 1989	(JP)	1-259393
Nov. 21, 1989	(JP)	1-302862

(51) **Int. Cl.**[7] **H01L 21/32**

(52) **U.S. Cl.** **438/166**; 438/485; 438/486

(58) **Field of Search** .... 437/173, 174, 437/967, 973, 83, 103, 109, 980, 983, 968, 913, 62, 485, 486, 166; 148/DIG. 1, DIG. 3, DIG. 90, DIG. 154, DIG. 122

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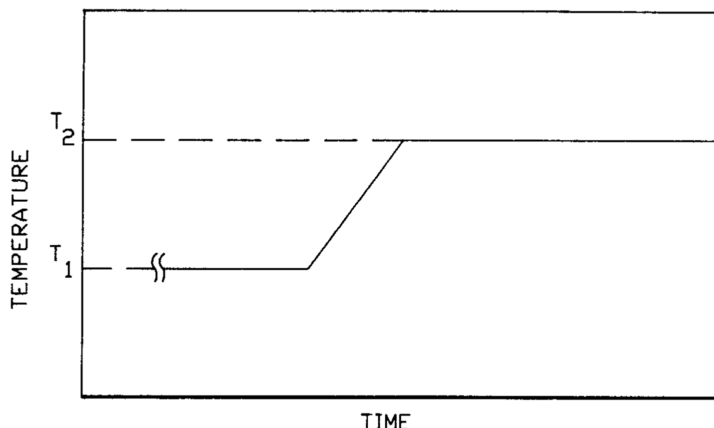
Primary Examiner—Charles Bowers
Assistant Examiner—Matthew Whipple

(57) **ABSTRACT**

An improved polycrystalline or polysilicon film having large grain size, such as 1 μm to 2 μm in diameter or greater, is obtained over the methods of the prior art by initially forming a silicon film, which may be comprised of amorphous silicon or micro-crystalline silicon or contains micro-crystal regions in the amorphous phase, at a low temperature via a chemical vapor deposition (CVD) method, such as by plasma chemical vapor deposition (PCVD) with silane gas diluted with, for example, hydrogen, argon or helium at a temperature, for example, in the range of room temperature to 600° C. This is followed by solid phase recrystallization of the film to form a polycrystalline film which is conducted at a relatively low temperature in the range of about 550° C. to 650° C. in an inert atmosphere, e.g., N or Ar, for a period of about several hours to 40 or more hours wherein the temperature is gradually increased, e.g., at a temperature rise rate below 20° C./min, preferably about 5° C./min, to a prescribed recrystallization temperature within the range about 550° C. to 650° C. Further, between the step of film formation and the step of solid phase recrystallization, the film may be thermally treated at a relatively low temperature, e.g., over 300° C. and preferably between approximately 400° C. to 500° C. for a period of several minutes, such as 30 minutes, to remove hydrogen from the film prior to solid phase recrystallization.

41 Claims, 11 Drawing Sheets



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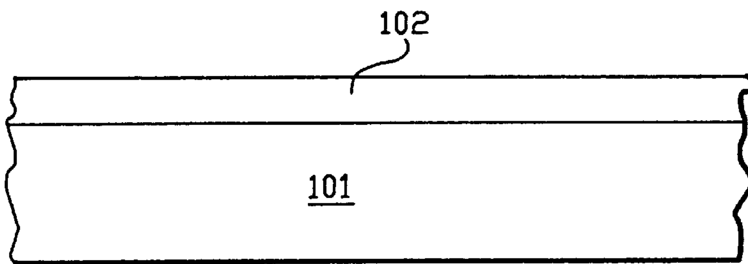

FIG.-1A

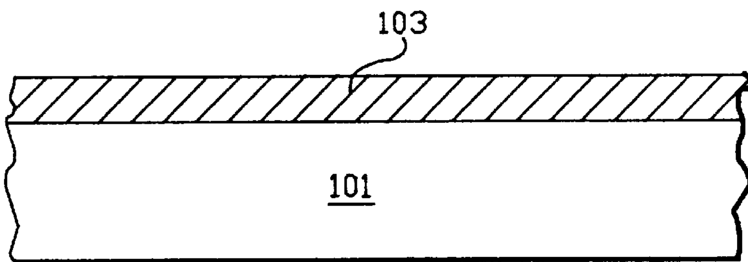

FIG.-1B

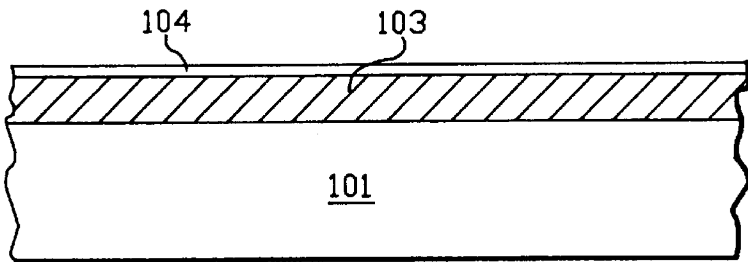

FIG.-1C

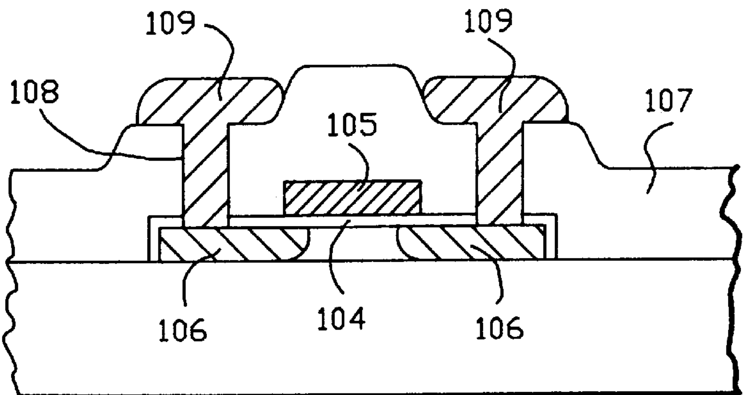

FIG.-1D

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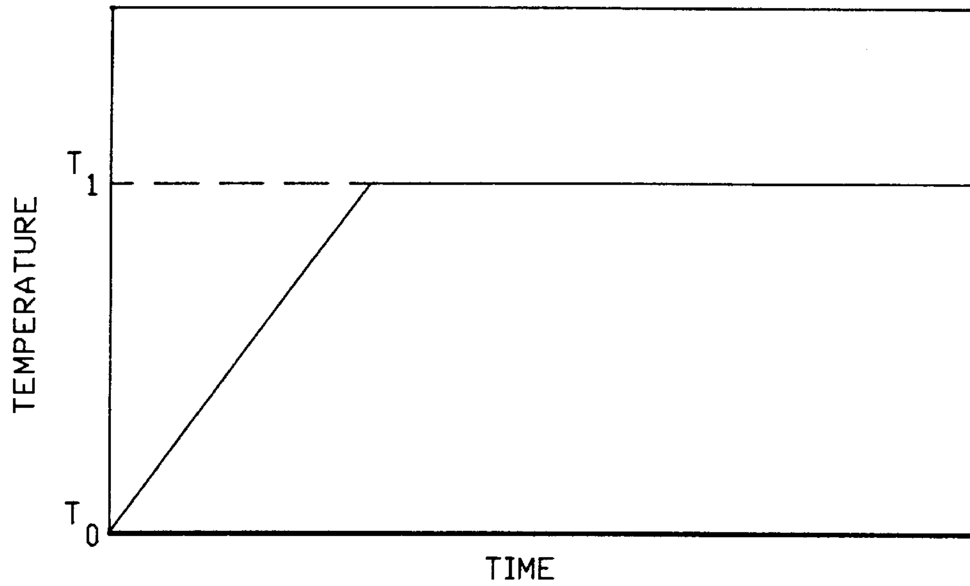

FIG.-2A

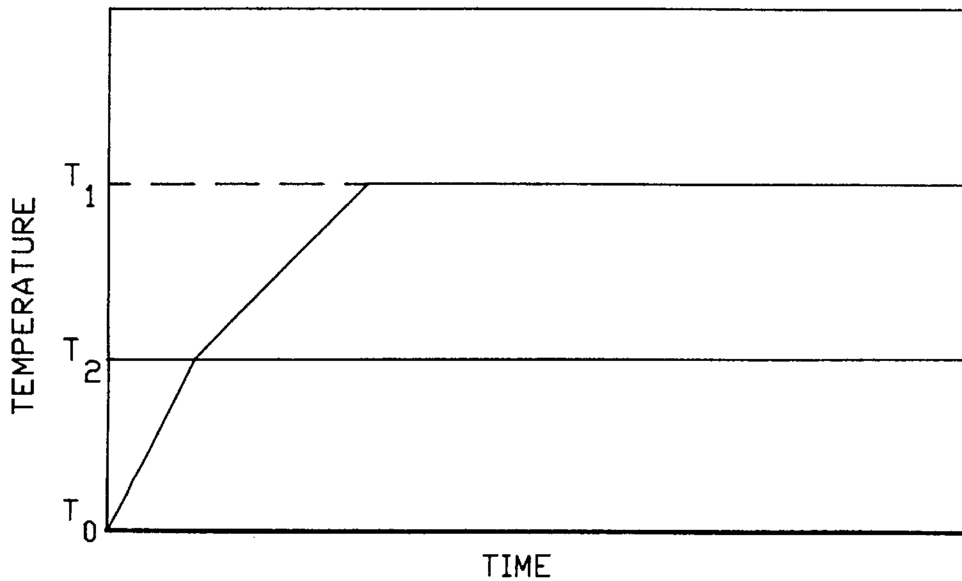

FIG.-2B

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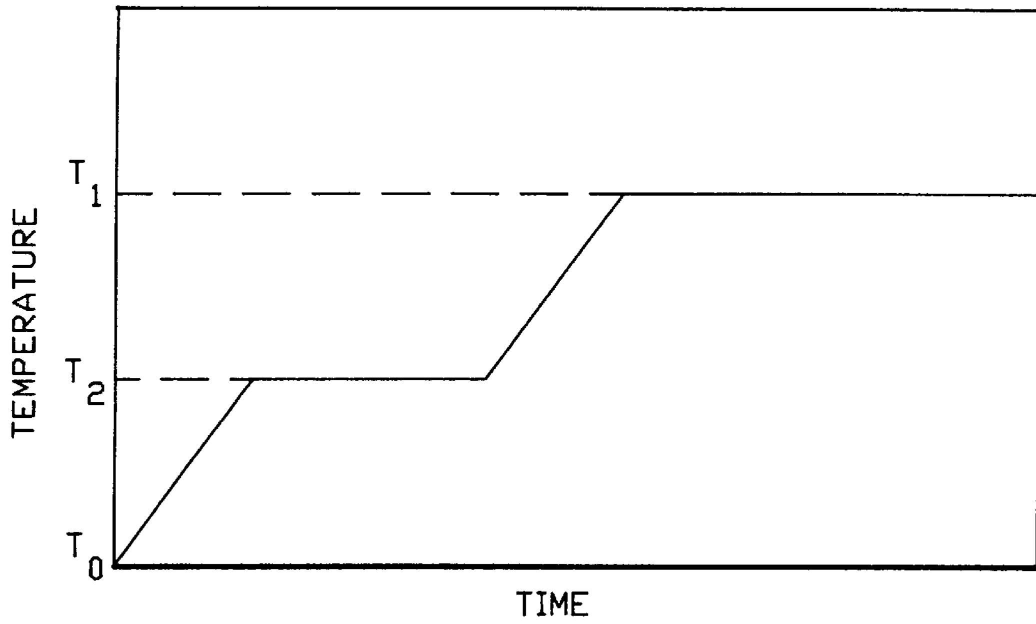

FIG.-2C

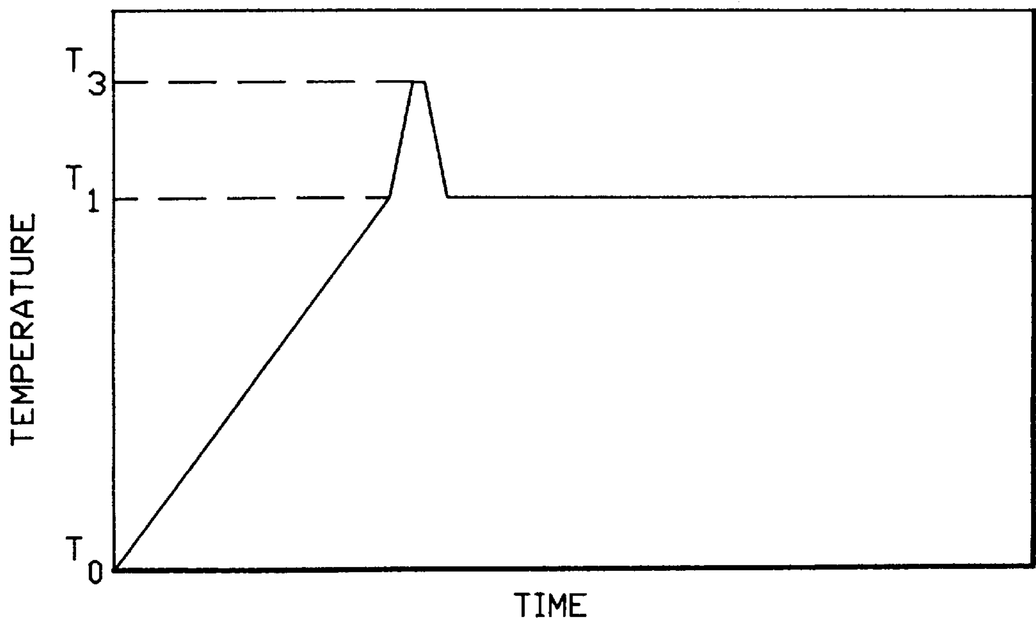

FIG.-2D

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